Translation of

AMENDMENT UNDER ARTICLE 19(35 U.S.C. 371(c)(3))

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CLAIMS

1. (amended) An optical module being an optical transmitter module or optical transmitter and receiver module internally comprising:

a measurement portion for measuring a laser diode temperature and bias current or only the temperature;

a storage portion in which the relationship between the temperature, bias current and wavelengths or between the temperature and wavelengths is stored; and

a central controlling portion for controlling the measurement portion and the storage portion; wherein

a wavelength of the laser diode is monitored by calculating the wavelength on the basis of the relationship stored in the storage portion.

2. The optical module according to Claim 1 comprising a laser diode drive current controlling circuit provided therein, which controls the drive current of the laser diode, and includes a feature of feeding the bias current information calculated from the measurement portion back to the laser diode drive current controlling circuit.

3. The optical module according to Claim 1 or 2 comprising a temperature adjusting portion composed of a temperature controlling device provided therein and includes a feature of feeding the wavelength information

calculated from the storage portion back to the temperature adjusting portion.

4. (amended) A method for monitoring wavelengths in an optical transmitter module or optical transmitter and receiver module internally including a measurement portion for measuring a laser diode temperature and bias current or only the temperature, a storage portion in which the relationship between the temperature, bias current and wavelengths or between the temperature and wavelengths and threshold values related to wavelengths are stored, and a central controlling portion for controlling the measurement portion and the storage portion, wherein the method comprising ~~a~~ steps of:

calculating wavelength information on the basis of the relationship between the temperature and bias current measured by the measurement portion or the temperature and the laser diode temperature and wavelength stored in the storage portion, or between the laser diode temperature, bias current and wavelengths; and

comparing the wavelength information with the threshold values to the wavelength.

5. The method for monitoring wavelengths according to Claim 4, wherein

the step for calculating wavelength information obtains λc, ic, a, and b in Equation (1) or λc and a in

Equation (2) by using the temperature and bias current or the temperature measured by the measurement portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information;

$$\lambda = \lambda c + aT + b(i - ic) \quad \text{.......Equation (1)}$$

$$\lambda = \lambda c + aT \quad \text{........Equation (2)}$$

(where λc is a wavelength at temperature 0°C and threshold current value ic, a and b are coefficients, T is a temperature, and i is a bias current).

6. The method for monitoring wavelengths according to Claim 4, wherein

the step of calculating wavelength information selects a smaller temperature value T1 than the measured temperature Tmes, a larger temperature value T2 than the measured temperature Tmes, a smaller bias current value I1 than the measured bias current Imes and a larger bias current value I2 than the bias current value Imes by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts four wavelengths ($\lambda 11 = \lambda(I1, T1)$, $\lambda 21 = \lambda(I2, T1)$, $\lambda 12 = \lambda(I1, T2)$, and $\lambda 22 = \lambda(I2, T2)$) corresponding thereto; and calculates the wavelength $\lambda mes1 = \lambda(Imes, T1)$ at the measured bias current Imes by linearly

interpolating the bias current dependency of the wavelengths at temperature T1 using λ11 and λ21; calculates the wavelength λmes2 = (Imes, T2) at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelength at temperature T2 using λ12 and λ22; and calculates the wavelength λmes = (Imes, Tmes) at the measured bias current Imes and temperature Tmes by linearly interpolating the temperature dependency of the wavelength at the bias current Imes using the calculated λmes1 and λmes2.

7. The method for monitoring wavelengths according to Claim 4, wherein

the step of calculating wavelength information selects a smaller temperature T1 than the measured temperature Tmes, a larger temperature T2 than the measured temperature Tmes, a smaller bias current I1 than the measured bias current Imes, a larger bias current I2 than the measured bias current Imes, and a bias current I3 differing from the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts six wavelengths (λ11 = λ(I1, T1), λ21 = λ(I2, T1), λ12 = λ(I1, T2), λ22 = λ(I2, T2), λ31 = λ(I3, T1), and λ32 = λ(I3, T2) corresponding thereto; approximates the bias current dependency of the wavelength at the temperature

T1 by a quadratic function using λ11, λ21 and λ31; approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using λ12, λ22 and λ32; and calculates the wavelength λmes = λ(Imes, Tmes) at the measured bias current Imes and temperature Tmes.

8. The method for monitoring wavelengths according to Claim 4, wherein

the step of calculating wavelength information extracts a wavelength information by causing the measured temperature and bias current to correspond to any one of the temperatures or the temperature and bias current stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelength stored in the storage portion.

9. A method for monitoring and controlling wavelengths of an optical transmitter module or optical transmitter and receiver module internally including: a measurement portion for measuring a laser diode temperature and bias current or only the temperature; a storage portion in which the relationship between the temperature, bias current and wavelengths or between the temperature and wavelengths is stored; a central controlling portion for controlling the measurement portion and the storage

portion; and a temperature adjusting portion composed of a temperature controlling device, wherein the method comprising steps of:

calculating wavelength information on the basis of the temperature and bias current or only the temperature measured by the measurement portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion; and

adjusting and controlling the internal temperature by feeding back to the temperature adjusting portion using the calculated wavelength information.

10. (amended) The method for monitoring and controlling wavelengths <u>according</u> to Claim 9, further comprising a step of:

comparing the threshold values, in which the minimum value and maximum value of wavelengths are predetermined, with the wavelength information calculated in the step of calculating wavelength information; wherein

the step for controlling temperature feeds back to the temperature adjusting portion when the result of comparison made by the wavelength information comparing step is outside the threshold values, lowering the internal temperature by the temperature adjusting portion when the result is smaller than or equal to the minimum value of the threshold values, and raising the internal temperature

by the temperature adjusting portion when the result is larger than or equal to the maximum value of the threshold values.

11. The method for monitoring and controlling wavelengths according to Claim 10, wherein,

the step of calculating wavelength information uses the temperature and bias current or only the temperature measured by the measuring portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information by obtaining λc, ic, a, and b in Equation (1) or λc and a in Equation (2);

$\lambda = \lambda c + aT + b(i - ic)$ ....Equation (1)

$\lambda = \lambda c + aT$ ....Equation (2)

(where λc is a wavelength at temperature 0°C and threshold current value ic, a and b are coefficients, T is a temperature, and i is a bias current).

12. The method for monitoring and controlling wavelengths according to Claim 10, wherein

the step of calculating wavelength information selects a smaller temperature value T1 than the measured temperature Tmes, a larger temperature value T2 than the measured temperature Tmes, a smaller bias current value I1 than the measured bias current Imes and a larger bias

current value I2 than the bias current value Imes by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts four wavelengths ($\lambda11 = \lambda(I1, T1)$, $\lambda21 = \lambda(I2, T1)$, $\lambda12 = \lambda(I1, T2)$), and $\lambda22 = \lambda(I2, T2)$ corresponding thereto; and calculates the wavelength $\lambda mes1 = \lambda(Imes, T1)$ at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelengths at temperature T1 using $\lambda11$ and $\lambda21$; calculates the wavelength $\lambda mes2 = (Imes, T2)$ at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelength at temperature T2 using $\lambda12$ and $\lambda22$; and calculates the wavelength $\lambda mes = (Imes, Tmes)$ at the measured bias current Imes and temperature Tmes by linearly interpolating the temperature dependency of the wavelength at the measured bias current Imes using the calculated $\lambda mes1$ and $\lambda mes2$.

13. The method for monitoring and controlling wavelengths according to Claim 10, wherein

the step of calculating wavelength information selects a smaller temperature T1 than the measured temperature Tmes, a larger temperature T2 than the measured temperature Tmes, a smaller bias current I1 than the measured bias current Imes, a larger bias current I2 than the measured bias current Imes, and a bias current I3 differing from

the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion and the relationships between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts six wavelengths ($\lambda11 = \lambda(I1, T1)$, $\lambda21 = \lambda(I2, T1)$, $\lambda12 = \lambda(I1, T2)$, $\lambda22 = \lambda(I2, T2)$, $\lambda31 = \lambda(I3, T1)$), and $\lambda32 = \lambda(I3, T2)$ corresponding thereto; approximates the bias current dependency of the wavelength at the temperature T1 by a quadratic function using $\lambda11$, $\lambda21$ and $\lambda31$; approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using $\lambda12$, $\lambda22$ and $\lambda32$; and calculates the wavelength $\lambda mes = \lambda(Imes, Tmes)$ at the measured bias current Imes and temperature Tmes.

14. The method for monitoring and controlling wavelengths according to Claim 10, wherein

the step of calculating wavelength information extracts a wavelength by causing the measured temperature and bias current to correspond to any one of the temperatures stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion.

15. The method for monitoring and controlling wavelengths according to Claim 9, wherein

the step of calculating wavelength information obtains λc, ic, a, and b in Equation (1) or λc and a in Equation (2) by using the temperature and bias current or only the temperature measured by the measuring portion, and the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion, and calculates wavelength information; and

the step of controlling temperature calculates a temperature, which gives a prescribed wavelength by using the calculated wavelength information and Equations (1) or (2), and feeds it back to the temperature adjusting portion so as to secure said temperature;

$\lambda = \lambda c + aT + b(i - ic)$ ....Equation (1)

$\lambda = \lambda c + aT$ ....Equation (2)

(where λc is a wavelength at temperature 0°C and threshold current value ic, a and b are coefficients, T is a temperature, and i is a bias current).

16. The method for monitoring and controlling wavelengths according to Claim 9, wherein

the step of calculating wavelength information selects a smaller temperature value T1 than the measured temperature Tmes, a larger temperature value T2 than the measured temperature Tmes, a smaller bias current value I1 than the measured bias current Imes and a larger bias current value I2 than the bias current value Imes by using

the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature and bias current and wavelengths stored in the storage portion; extracts four wavelengths ($\lambda11 = \lambda(I1, T1)$, $\lambda21 = \lambda(I2, T1)$, $\lambda12 = \lambda(I1, T2)$, and $\lambda22 = \lambda(I2, T2)$ corresponding thereto; and calculates the wavelength $\lambda mes1 = \lambda(Imes, T1)$ at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelengths at temperature T1 using $\lambda11$ and $\lambda21$; calculates the wavelength $\lambda mes2 = (Imes, T2)$ at the measured bias current Imes by linearly interpolating the bias current dependency of the wavelength at temperature T2 using $\lambda12$ and $\lambda22$; and calculates the wavelength $\lambda mes = (Imes, Tmes)$ at the measured bias current Imes and temperature Tmes by linearly interpolating the temperature dependency of the wavelength at the measured bias current Imes using the calculated wavelength $\lambda mes1$ and $\lambda mes2$; and

the step for controlling temperature calculates a temperature, which gives a prescribed wavelength at the measured bias current Imes, on the basis of the temperature dependency of the wavelength, and feeds it back to the temperature adjusting portion so as to secure the calculated temperature.

17. The method for monitoring and controlling wavelengths according to Claim 9, wherein

the step of calculating wavelength information

selects a smaller temperature T1 than the measured temperature Tmes, a larger temperature T2 than the measured temperature Tmes, a smaller bias current I1 than the measured bias current Imes, a larger bias current I2 than the measured bias current Imes, and a bias current I3 differing from the bias currents I1 and I2 by using the temperature and bias current measured by the measurement portion, and the relationship between the laser diode temperature, bias current and wavelengths stored in the storage portion; extracts six wavelengths ($\lambda 11 = \lambda(I1, T1)$, $\lambda 21 = \lambda(I2, T1)$, $\lambda 12 = \lambda(I1, T2)$, $\lambda 22 = \lambda(I2, T2)$, $\lambda 31 = \lambda(I3, T1)$, and $\lambda 32 = \lambda(I3, T2)$ corresponding thereto; approximates the bias current dependency of the wavelength at the temperature T1 by a quadratic function using $\lambda 11$, $\lambda 21$ and $\lambda 31$; approximates the bias current dependency of the wavelength at the temperature T2 by a quadratic function using $\lambda 12$, $\lambda 22$ and $\lambda 32$; and calculates the wavelength $\lambda mes = \lambda(Imes, Tmes)$ at the measured bias current Imes and temperature Tmes; and

the step for controlling temperature calculates a temperature, which gives a prescribed wavelength at the measured bias current Imes, on the basis of the temperature dependency of the wavelength, and feeds it back to the temperature adjusting portion so as to secure the calculated temperature.

18. The method for monitoring and controlling

wavelengths according to Claim 9, wherein

the step of calculating wavelength information extracts a wavelength information by causing the measured temperature and bias current to correspond to any one of the temperatures stored in matrices indicating the relationship between the laser diode temperature and wavelengths or between the laser diode temperature, bias current and wavelengths stored in the storage portion; and

the step of controlling temperature extracts a temperature from the matrices, which gives a prescribed wavelength at the corresponding bias current, and feeds it back to the temperature adjusting portion so as to secure the extracted temperature.

19. A method for monitoring and controlling wavelengths according to any one of Claims 9 through 18, further comprising a laser diode drive current controlling circuit which controls the drive current of the laser diode, wherein, the method further comprising, before the step of calculating wavelength information, steps of:

comparing threshold values of an optical output alarm or warning, in which the minimum value and maximum value of optical output are predetermined, with the optical output measured by the measurement portion; and

on the basis of a comparison made by the optical output comparing step, feeding the result back to the laser diode drive current controlling circuit when the result is outside

the range of the threshold values, raising the bias current by the laser diode drive current controlling circuit if the result is smaller than or equal to the minimum value of the threshold values, and lowering the bias current by the laser diode drive current controlling circuit if the result is larger than or equal to the maximum value of the threshold values.